Issued January 17, 1916.

U. S. DEPARTMENT OF AGRICULTURE,

BUREAU OF SOILS—MILTON WHITNEY, Chief

IN COOPERATION WITH THE UNIVERSITY OF MISSOURI AGRICULTURAL EXPERIMENT STATION, F. B. MUMFORD, DIRECTOR.

SOIL SURVEY OF GRUNDY COUNTY, MISSOURI.

BY

A. T. SWEET, OF THE U. S. DEPARTMENT OF AGRICULTURE, AND W. I. WATKINS, OF THE UNIVERSITY OF MISSOURI.

CURTIS F. MARBUT, INSPECTOR IN CHARGE.

[Advance Sheets—Field Operations of the Bureau of Soils, 1914.]

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1916.

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LETTER OF TRANSMITTAL.

U. S. Department of Agriculture,
Bureau of Soils,
Washington, D. C., July 14, 1915.

Sir: In the extension of the soil survey in the State of Missouri during the field season of 1914 work was undertaken in Grundy County. This work was done in cooperation with the University of Missouri Agricultural Experiment Station, and the selection of this area was made after conference with State officials.

I have the honor to transmit herewith the manuscript report and map covering this area and to recommend their publication as advance sheets of Field Operations of the Bureau of Soils for 1914, as authorized by law.

Respectfully,

Milton Whitney,
Chief of Bureau.

Hon. D. F. Houston,
Secretary of Agriculture.

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Soil map, Grundy County sheet, Missouri.

SOIL SURVEY OF GRUNDY COUNTY, MISSOURI.

By A. T. SWEET, of the U. S. Department of Agriculture, and W. I. WATKINS, of the University of Missouri.

DESCRIPTION OF THE AREA.

Grundy County is situated in the north-central part of Missouri, 80 miles northeast of Kansas City and 110 miles west of Quincy, Ill. It is bounded on the north by Mercer County, which separates it from Iowa, on the east by Sullivan and Linn Counties, on the south by Livingston County, and on the west by Daviess and Harrison Counties. It is almost a square in outline, having a length and breadth of slightly less than 21 miles. It has an area of 440 square miles, or 281,600 acres.

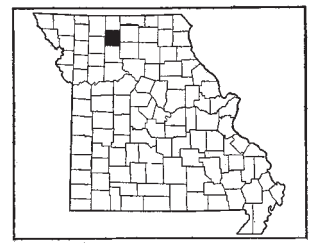


FIG. 1.—Sketch map showing location of the Grundy County area, Missouri.

The surface of the greater part of the county consists of an upland plain having an elevation of 800 to 1,000 feet above sea level, and gently sloping toward the south. Into the upland there have been cut, at intervals of only a few miles, long, straight, nearly parallel valleys. The corresponding long ridges between the valleys reach, or nearly reach, the maximum elevation of the original plain. These valleys and ridges have an almost due north and south trend, and the ridges have been dissected by numerous small tributary streams which enter the larger valleys approximately at right angles. Between the small streams are corresponding short ridges, which extend out from the main divides, so that the county as a whole has a double arrangement of ridges, the main ridges running north and south, the small ones nearly east and west.

The main valleys range in width from less than half a mile to over 2 miles, and the intervening uplands from 3 to about 5 miles. Along the axial lines of the upland ridges there are in many places long, narrow, nearly level or gently undulating areas, but only a few small flat or poorly drained areas occur.

The difference in elevation between the flood plains of the main valleys and the gently rolling uplands along the tops of the ridges is 150 feet or more, so that some of the small lateral streams have a fall of several feet to the mile, depending on their length, and when

filled with water after heavy rains they erode very actively. In some cases, however, the smaller streams do not flow directly into the larger ones, but parallel them for a considerable distance before turning rather abruptly to discharge into them, and thus the current and eroding power of the branches are reduced. All these small tributaries are intermittent. All the upland is well drained and some parts have excessive drainage. In only a few small areas, however, are the slopes too steep for cultivation.

West of Grand River and south of Sugar Creek the topography and drainage vary from the general type found in the rest of the county. The elevation is nearly a hundred feet higher, but the greatest difference lies in the branching or dendritic arrangement of the drainage lines, in place of the parallel arrangement found in the rest of the county, and in the sharpness of the dissection. The topographic or relief profile is angular rather than rounded, as is the case elsewhere in the county. In other words, the uplands are smooth, while the valleys are sharply cut, except the shallow ones or the upper slopes of the deeper ones.

A glance at the map will show the wide difference in arrangement of the main topographic features between this area and the rest of the county.

The occurrence in this region of a bed of resistant limestone lying well above the grade levels of the streams, in contrast to its entire absence or occurrence very near the grade level of the streams in other parts of the county, is undoubtedly responsible for the angularity of the profile and the general roughness of the dissected part of this area, and it may also be responsible for the dendritic arrangement of the drainage lines.

The main stream valleys of the county are broad and flat and at time subject to overflow. Through these valleys the streams follow very crooked or meandering courses, usually near the center of the valleys, rarely flowing against the steep slopes or bluffs lying at each side. Numerous cut-offs or horseshoe lakes have been formed through the changing of the stream channels. These lakes and the present stream channels are bordered on one side or both by low natural levees, which are usually most pronounced on the outer or convex side of the curves. In many places well-defined terraces which vary in height from 4 to as much as 10 feet separate the low, frequently overflowed bottoms adjacent to the stream channels from slightly higher bottoms, which are also subject to overflow, but not so frequently. In some places there are two or even three of these low terraces. In several places along the outer edge of the valleys of Grand River and Weldon and Thompson Forks and in a few places along the valleys of some of the smaller streams, there are well-defined terraces of considerable extent. These occur at

elevations of 30 to 60 feet above the level of the valley floor and far above any recent high-water stage. In the flood plains of Grand River and Weldon and Thompson Forks there are a few isolated islandlike mounds which cover areas of 1 to 4 acres each. These are composed of material unlike that of the adjacent uplands or of sediment now carried by the rivers.

In a few places the larger valleys have been narrowed or restricted by the encroachment of rocky bluffs or by other material which has offered considerable resistance to erosion. A good example of this may be seen on Medicine Creek at Laredo, on Thompson Fork west of Parkerton, and on Weldon Fork 2 miles northeast of Parkerton. In each case a large body of heavy soil lies in the valley immediately above, seemingly due to more or less ponding of the stream during periods of high water.

Grand River and several of its important tributaries cross the county in a north and south or nearly north and south direction. Weldon Fork, or "Little River," as it is commonly called, unites with the Thompson Fork of Grand River 2 miles northwest of Trenton, the region between these two streams being known as the "Forks-of-the-river country."

The first permanent settlements in Grundy County were made in 1833. The early settlers came largely from other parts of Missouri and from Kentucky, Ohio, Indiana, and Illinois. The population in 1910, according to the census, was 16,744, a slight decrease from that of 1900 and 1890, and only a slight increase over that of 1880. Less than 1 per cent of the population is colored and less than 2 per cent is of foreign birth. Approximately one-half of the entire population resides in Trenton, Laredo, Spickard, and Galt. Considering the remainder of the population as rural, there are approximately 20 persons to the square mile in the rural districts. The population is quite evenly distributed, except that it is generally sparser in the bottom lands.

Trenton, the county seat, situated near the center of the county, had in 1910 a population of 5,656. It has manufacturing and commercial interests of importance. Spickard, in the northern part of the county; Galt, in the eastern part; and Laredo, in the southeastern part, are towns of importance, with populations ranging between 600 and 900. Other smaller towns are Brimson and Dunlap, on the Quincy, Omaha & Kansas City Railroad, and Tindall and Hickory Creek, on the Chicago, Rock Island & Pacific Railway.

Three lines of railroad serve Grundy County—the Chicago, Rock Island & Pacific, which crosses it from north to south, giving direct communication with Kansas City, St. Joseph, and Chicago; the Chicago, Milwaukee & St. Paul, which crosses the southeastern corner of the county, furnishing a direct line to Kansas City; and

the Quincy, Omaha & Kansas City Railroad, a part of the Burlington Route, which crosses the county east and west. Kansas City is the principal stock market for this section, especially for hogs and cattle. Some stock, however, is shipped to Chicago, horses and mules to St. Louis, and live and dressed poultry principally to New York.

The county is well supplied with public roads, which in general follow land lines, regardless of topography, and are being improved by grading of the road bed and by dragging. Little has yet been done to improve the roads by making cuts or fills where necessary. Almost every home in the county is reached by rural mail routes and has telephone communication.

CLIMATE.

The climate of Grundy County is in general that of northern Missouri and southern Iowa, and is well suited to general farming and stock raising.

The following table gives the normal monthly, seasonal, and annual temperature and precipitation, compiled from the records of the Weather Bureau station at Trenton:

Normal monthly, seasonal, and annual temperature and precipitation at Trenton.

Month.	Temperature.			Precipitation.		
	Mean.	Absolute maximum.	Absolute minimum.	Mean.	Total amount for the driest year.	Total amount for the wettest year.
	°F.	°F.	°F.	*Inches.*	*Inches.*	*Inches.*
December	29.6	63	−14	1.38	1.14	1.41
January	27.0	66	−16	1.36	1.95	3.30
February	26.7	68	−25	1.31	2.42	.90
Winter	27.8			4.05	5.51	5.61
March	40.1	85	0	2.26	2.13	3.41
April	52.3	86	12	2.97	2.24	3.93
May	63.8	89	22	5.11	1.40	6.70
Spring	52.1			10.34	5.77	14.04
June	71.9	97	43	4.16	1.70	6.84
July	75.8	105	53	3.94	2.37	4.70
August	74.8	99	48	3.82	4.14	2.63
Summer	74.2			11.92	8.21	14.17
September	67.1	98	30	3.40	.27	5.10
October	56.5	90	22	2.20	.38	5.01
November	41.4	72	2	1.73	3.32	1.74
Fall	55.0			7.33	3.97	11.85
Year	52.3	105	−25	33.64	23.46	45.67

The mean annual precipitation of 33.64 inches is well distributed and sufficient, under proper methods of tillage, to produce good yields of all the common crops. The distribution is favorable, the rainfall being lightest during the winter and heaviest during the spring and summer months. May has the heaviest precipitation, and more than half the normal rainfall occurs during the four growing months of May to August. Torrential rainfall and the loss of large amounts of moisture through rapid run-off are rare.

The average date of the last killing frost in spring is April 20 and of the first in fall October 9. This gives an average growing season of 172 days, which is sufficient for all ordinary crops.

Periods of excessive rainfall sometimes delay spring plowing, and may be followed by periods of drought, during which the ground becomes so hard and cloddy that it can scarcely be worked. This difficulty can be avoided to a large extent by disking or double-disking the ground before breaking, and as soon as it becomes sufficiently dry to work well.

Periods of excessive heat and drought accompanied by hot winds during the summer season occasionally cause injury to corn, oats, meadow grasses, and pastures. Injury to fruit sometimes results from periods of warm weather in late winter or early spring followed by hard freezes. On the bottom lands considerable loss results at times from floods.

AGRICULTURE.

The latest census shows a considerably greater total value of live-stock products in Grundy County than that of all the crops produced. This fact justifies the statement that the agriculture of the county consists primarily of stock raising based upon the growing of grain and forage crops. Some attention is given to trucking and orcharding, but the principal exports are live stock and animal products. Through this method of farming the soils of the county have been maintained in a high state of fertility.

Farming has been carried on in Grundy County since the first permanent settlements were made. A considerable part of the county has been under cultivation for more than 50 years.

The early settlers located along the streams, where water and wood were abundant and where there was protection from the weather in winter. It is said that at that time almost the entire county was forested, much of the stream bottoms and the hill slopes being quite densely covered with large white oak, walnut, elm, and hard maple, with some black, red, and chestnut oak. On the ridges the growth was much less dense and consisted largely of clumps of hickory, oak, and elm, and thickets of hazel and sumac. Luxuriant growths of bluestem and other native grasses furnished excellent pasturage for

horses and cattle during the grazing season, and hogs fattened on the rich mast, consisting of nuts and acorns, in the fall. Only small fields of corn were grown, for winter use. Some farmers grew a few acres of wheat or buckwheat for home use and had it ground at the nearest water mill. The more open ridge land, although unlike the open grass-covered prairies farther east and south, was spoken of as prairie land and was considered less desirable than the more heavily forested hill slopes and bottoms. As settlement increased it was gradually extended into the prairie section of the county. During this period there was an abundance of good open range, and cattle were sent from the range directly to the market. For many years, however, practically the entire area of the county has been under cultivation or fenced and used for pasture.

As the native wild grasses have been killed out through cultivation or too heavy pasturing, bluegrass, white clover, timothy, and redtop have taken their place, the bluegrass and white clover getting a foothold and gradually spreading without any special preparation of the land or seeding. Timothy, clover, millet, and alfalfa constitute the principal hay crops. Corn is the principal grain and is also used for silage and cut for stover. Oats are grown to a considerable extent, being thrashed and also fed in the sheaf and sometimes cut for hay. Millet occupies a considerable acreage, being frequently used on land which, on account of unfavorable local conditions, can not be planted to corn. The principal crops sold directly and shipped out of the county are wheat, oats, millet seed, timothy seed, bluegrass seed, hay of different kinds, and straw.

The following figures, based upon the Missouri Crop Review for 1913, upon information collected from farmers, and upon observations in the field, indicate the relative importance of the different crops of Grundy County. The statement gives the estimated per cent of the total area of the county devoted to the following uses or crops: Pasture land, 44 per cent; corn, 30 per cent; timothy (often including some clover), 12 per cent; oats, 2.5 per cent; wheat, 1 per cent; clover, 0.5 per cent; alfalfa (more than one-half less than 1 year old), 0.4 per cent; and miscellaneous crops, including rye, millet, sorghum, truck crops, orchards, and waste land, 10 per cent.

Corn is by far the most important cultivated crop of the county. In 1913 there were 77,531 acres planted to this crop and the production was 1,860,744 bushels, an average of 24 bushels per acre.[1] This yield, although extremely low on account of unusual drought and heat, was exceeded in only 11 other counties in the State. Under normal climatic conditions the yields range from 30 to 50 bushels or

[1] Missouri Crop Review for 1913.

more per acre, some fields on the bottom lands producing an average of 50 bushels for periods of several years.

Owing to better crop rotations, in which corn is grown on the same land for not more than two or three years in succession, the systematic use of manure, a more general growing of leguminous crops, better preparation of the seed bed, the use of improved and tested seed, and persistent shallow cultivation, the yields are gradually increasing.

Some fall plowing, especially of pasture and meadow land, is done, but the greater part of the corn land is plowed in the spring. The custom of the better farmers is to disk and sometimes double-disk the land before breaking. This has the advantage of forming a mulch on the surface which keeps the ground in good condition for breaking for many weeks, being especially advantageous in dry seasons. It also cuts up stalks and trash, so that they can be plowed under, and stirs that part of the seed bed in which the plants will develop an important part of their root system. The average depth of breaking is 5 or 6 inches, although some farmers break their ground to a depth of 7 or 8 inches, and nearly all say that the best results are obtained from rather deep breaking for corn. If ground is plowed in the fall, it is allowed to remain rough until spring. The spring breaking is disked and often double-disked, then harrowed or dragged before seeding. Much of the corn land, especially on the uplands, is checked and cultivated both ways. On the bottom lands it is usually either drilled or listed. Corn is cultivated three to five times, depending on the season, the most successful growers continuing shallow cultivation until the corn becomes too high for a two-horse cultivator. The tendency seems to be toward deeper breaking, better preparation of the seed bed, and more frequent shallow cultivation without high ridging.

Reids yellow dent is the principal variety of corn grown in the county. On the bottom lands some Boone County White, Iowa Silver Mine, and Johnson County White are planted.

Corn is almost the only crop used for ensilage. Much of it is cut with binders, with machine cutters, or by hand and shredded or fed from the shock. The remainder is either husked or pulled, ear and husk, the stalks being pastured during the winter. The crop is planted from April 20 to June 1 and, with the exception of very late plantings, is rarely injured by early frosts.

The stream-bottom soils are used extensively for corn and those of lighter texture are the most productive corn soils of the county. The heavier Wabash clay and clay loam are also used extensively for this crop and under favorable seasonal conditions produce good yields. The yields on the uplands do not average so high as on the

bottom lands, but the Grundy silt loam and the better portions of the Shelby loam are both good corn soils.

Little corn is shipped out of the county; on the contrary, grain is frequently shipped in from Iowa or Kansas for use in fattening cattle and hogs.

Next to corn, oats are the most important grain crop of the county. In 1913 there were 6,492 acres sown, which produced 207,744 bushels, or 32 bushels per acre.[1] Only four counties in the State reported a higher average yield. The principal varieties grown are Red Rustproof, Early Champion, and Kherson. The crop almost invariably follows corn, the ground usually being double-disked, then harrowed. In most cases oats are sown broadcast, but some farmers prefer drilling. Oats are usually cut with a binder and thrashed from the shock or stacked. Oats are used extensively as feed for work stock, sheep, calves, and poultry. The straw is used as roughage or baled and shipped. On the bottom lands the plants tend to make too rank a growth of straw, often rusting and falling down. Oats are grown principally on the uplands.

The acreage of wheat is not large, only 3,397 acres being reported in 1913, with a production of 74,734 bushels, or an average of 22 bushels per acre. Only six counties in the State report a larger yield per acre. Wheat usually follows oats or corn. When it follows oats the ground is plowed in the late summer and thoroughly disked to give a firm, compact undersoil. When it follows corn the corn is cut for silage, or put in the shock and the ground thoroughly disked and cross-disked. Wheat is sown in this region between the 1st and 20th of September. The worst wheat pest is the Hessian fly, which often does considerable damage, especially to wheat which is sown early. The principal varieties grown are Turkey Red, Fultz, and Harvest King.

A few farmers use acid phosphate or bone meal in small quantities on wheat and report favorable results, especially to the clover and timothy following.

Many farmers grow wheat because it offers the best opportunity for getting a stand of clover and timothy. Timothy is sometimes sown with the wheat in the fall, but clover is always sown in the spring. Clover and timothy are sometimes sown together in the spring on the wheat ground. Some farmers harrow the wheat lightly after the seed is sown, but others sow early, trusting to freezing and thawing to cover the seed.

Rye is grown to some extent for winter and spring pasture. It is then plowed under or allowed to mature and cut for grain. Yields of 15 to 25 bushels per acre are obtained. Timothy is also sown with rye and with oats.

[1] Missouri Crop Review for 1913.

Clover is an important crop, not alone for its value as a forage, hay, and seed crop, but also for its efficacy in improving the soil structure and adding nitrogen collected from the air. It is usually cut over in the fall following the spring seeding, or used for pasturage. The second year the first cutting is used for hay and the second for seed or hay. The yields the second year range from 1½ to 2½ tons per acre for the two cuttings. The yields of seed vary greatly, ranging from less than a bushel to as much as 5 bushels per acre. Clover does well on all the deep, well-drained soils of the county. The heavy, poorly drained bottom soils are naturally not well suited to red clover, although they may be brought into a much more favorable condition by thorough drainage and in some cases by the application of lime or ground limestone. On land too wet for red clover, alsike clover, although it does not yield so large a hay crop, is an excellent substitute and may be grown on almost any of the bottom lands.

Alfalfa is receiving more attention in Grundy County than any other minor crop at the present time, owing to the success attained in small fields during the last few years. Many farmers are seeding small areas to this legume. There are large sections of the county on which this crop will succeed. Alfalfa, like red clover, requires a rich, deep, well-drained soil. The practice usually followed in this county is to break the ground in late spring or early summer and keep it well cultivated until about the 1st of September, thus putting it into an excellent state of tilth and germinating all seed in the soil or in the manure which may have been applied to it. Lime or ground limestone is then applied. The soil is very finely pulverized and inoculated, and the seed is lightly covered. The soils best suited to alfalfa are the very fine sandy loams and light silt loams near the channels of the larger streams. Of the upland soils the areas of deep, rich, brown loam where the clay is well covered are best. Not much lime is needed in such places. The crop may also be grown on the black, silty soil on the tops of the ridges. Here lime is in most cases necessary. Under favorable seasonal conditions alfalfa yields three cuttings of one-half ton to 1¼ tons per acre at each cutting.

Ground limestone is applied by some farmers to land intended for alfalfa. In many cases this is necessary in order to get and maintain a good stand, and probably in most cases it would be beneficial.[1]

A few farmers are successfully growing cowpeas and soy beans. These crops do best on good corn or clover land, but they do better than alfalfa on thin soils and those that are acid.

[1] Soil Acidity and Liming, Monthly Bulletin, Missouri State Board of Agr., Feb., 1914.

Bluegrass is used extensively for pasturage, being the principal pasture grass of this region. It thrives on the heavy gumbo soil of the bottoms, on the uplands, and on the steep and rocky slopes unsuited for other crops. When forest lands are cleared and pastured they soon become thickly set with bluegrass. In timothy and redtop meadows it soon gets a foothold. In alfalfa fields it is a serious pest. Bluegrass pastures are usually ready for stock by the 1st of May, and if there is sufficient moisture they furnish excellent pasturage until late in October or early in November. The most serious objection to bluegrass is that it does not withstand drought well. However, it revives very quickly after periods of drought. Bluegrass is not usually seeded, but timothy or timothy and clover are pastured until the bluegrass gets a foothold. Some of the more progressive farmers have found that a stand can be obtained much quicker and more profitably by preparing the land and sowing the seed. Where steep, forested hill slopes are to be put into bluegrass it is usually best to avoid erosion by seeding on the unplowed ground. Weeds of different kinds, especially ironweed, and buckbrush, are serious pests in bluegrass pastures.

Bluegrass seed is a product which pays well without greatly reducing the value of the pasturage. This seed is rarely harvested by the owner of the land, but is sold by the acre to men who make a business of harvesting seed. When the seed is ripe seed-collecting machines are driven over the pastures. The seed is dried, cleaned, and sacked. In 1912 there were shipped out of the county 6,000 pounds of bluegrass seed, 10,508 bushels of millet seed, and 1,835 bushels of timothy seed.[1]

The prevailing crop rotation consists of corn for one, two, or three years, then oats or wheat, followed by clover and timothy. The more successful farmers on the uplands plant corn for one year, or at most for two years in succession. When this is followed by oats, the latter are often followed by wheat, and the wheat by clover and timothy. On the bottom lands corn is often planted for three years or more in succession and good yields obtained, but some farmers continue to plant this crop until the yields markedly decline, after which the land is kept in pasture for several years before being used again for corn.

Considerable difficulty is sometimes experienced, especially during seasons of unusual drought, in obtaining a good stand of clover. The rotation is then seriously impaired by losing the legume member, which is the most beneficial in building up the soil. Some farmers have found that by using small quantities of commercial fertilizers, usually those high in phosphates, with the wheat a stand of

[1] Missouri Red Book, 1912.

clover is more easily obtained. Others have found lime beneficial. In many cases both of these can be used to advantage.

The following table shows approximately the number of live stock and the quantities of farmyard and dairy products exported from Grundy County during the year 1911:

Live stock:		
Cattle	head	12,350
Hogs	do	40,323
Horses and mules	do	1,081
Sheep	do	11,241
Jacks and stallions	do	38
Farmyard products:		
Live poultry	pounds	1,548,393
Dressed poultry	do	188,018
Eggs	dozens	957,120
Feathers	pounds	13,009
Dairy products:		
Butter	pounds	86,441
Ice cream	gallons	12,397
Milk and cream	do	24,313

Data collected from a number of farmers indicate that the average number of live stock for a 160-acre farm is approximately 6 horses, 21 head of cattle, 26 hogs, 10 sheep, and 120 chickens. The grade of stock as a whole is good, but there is room for improvement. There is also need of considerable increase in the number of stock, especially of cattle. Horses, cattle, hogs, and poultry are kept on almost every farm in the county, while sheep are found on probably not over one-third of the farms.

The predominant breeds of beef cattle are the Shorthorn and the Hereford, which seem to be about equally divided through the county. There are some Angus. In the dairy herds the Jersey predominates, although some Holstein and many cows of mixed breeds are found. Many dairymen and farmers are attempting to build up their herds by the use of purebred bulls and grade cows.

On account of the good markets for cream and butter offered by Kansas City and St. Joseph the dairy business has become an important one in Grundy County. There are many silos and the number is increasing each year.

Farm improvements in Grundy County are substantial and indicative of prosperity (see Pl. I, figs. 1 and 2). Many farms have gravity water systems for house and other buildings. The average value of all property per farm is given in the 1910 census as $10,579, and the average land value per acre as $57.96, more than twice that in 1900.

According to the 1910 census, 72.7 per cent of the farms in Grundy County are operated by the owners. Where land is rented on

shares the tenant usually furnishes work stock, feed, and implements, and gives one-half the corn in the crib, one-half the hay in the stack, one-half the wheat thrashed, and one-third of the oats. For pasture land he pays $2.50 to $4 an acre. Cash rents range from $3 to $5 an acre.

Land values range from $40 or $50 an acre for the rougher or less desirable lands to over $125 for the better, well-located lands. The average value for the county is probably about $80 an acre.

SOILS.

Three layers of material underlie the surface of Grundy County and have contributed in varying degree to the soils as they exist at present. The three layers were probably continuous at the time they were formed and only the top one was exposed at the surface. At the present time it has been removed over so large an area that the second layer lies at the surface over most of the county. This can be seen by comparison on the soil map of the area of the Grundy soils, which represent the top layer, with that of the Shelby and Lindley soils, which represent the distribution of the second layer.

The top layer, where not changed in its characteristics by the soil-making processes, consists of a light-colored silty material, usually known as clay, free from stone, gravel, or sand, except a small percentage of the finest grades of the latter. On account of its fine-grained character, its wide distribution, and its freedom from gravel, stones, and coarse sand, it is thought to have been accumulated on the surface as dust transported by the wind. It represents an accumulation during long ages of time.

It seems to have had an original thickness of a little less than 20 feet. At the present time its thickness ranges from nearly 20 feet down to nothing, depending upon the extent to which it has suffered from erosion. From this layer the Grundy soils have been formed.

The second layer consists of a bluish sandy clay with stones and bowlders in varying quantities. The blue color is rarely seen, because of the change in color at the surface by the action of soil-making processes. In places not typical it has neither sand nor gravel in noticeable quantities. On account of the character of this material, which shows that much of it was brought from the Lake Superior region or Canada, and on account of its relation to the other layers and to the material in near-by regions, there seem to be good reasons for concluding that it is a deposit from a great sheet of ice that invaded the whole of northern Missouri a long time ago. Its thickness ranges from 50 feet or more down to nothing. Soil-making processes have developed the Shelby and Lindley soils from this second layer.

FIG. 1.—A WELL-IMPROVED FARM ON THE UPLAND OR PRAIRIE SOILS NEAR TRENTON.
Cowpeas in foreground. Silo in process of construction,

FIG. 2.—CHARACTER OF FARM IMPROVEMENTS SEEN IN MANY PARTS OF THE COUNTY ON GRUNDY SILT LOAM, LINDLEY SILTY CLAY LOAM, AND BETTER GRADES OF SHELBY LOAM.

A Field of Alfalfa on Good Shelby Loam near Trenton.

The third or bottom layer, the lowest that is exposed at the surface, consists of beds of consolidated rock. In the western part of the county, and especially in the southwestern part, it consists of alternating layers of hard limestone and shale, while in the eastern part, that lying east of the longitude of Trenton, it consists of shale or "soapstone." There is a small amount of sandstone in the shale, but it is not conspicuous. These rocks are the hardened remnants of ancient mud and limy deposits laid down under rather shallow water. They are many times older than either of the other two layers. They extend downward far below any of the existing valleys and below the depths reached by any well. The Rough stony land and the Boone very fine sandy loam are derived from these rocks.

From what has been said of these three layers of material it is evident that the upper layer or the layer of clay without sand or gravel will be found in the higher parts of the county. The sandy clay layer with the gravel will be found on the slopes and low ridges, while the limestone and soapstone beds will be found only on the lower slopes of the valleys below the levels of the other two.

Through the action of the air, rain water, and vegetation, the surface layer of each of these materials has been converted into soil. The air and the rain water have changed the normal bluish colors of the original material to yellows, browns, reds, or grays, while the vegetable matter that has accumulated in them has turned them dark in color. The latter has affected only the upper foot of the material as a rule, while the yellow or red color induced by air and water action may extend to a depth of several feet. Another effect of the action of the rain water on the soil is to wash the finer grained material out of the surface foot of the soil and carry it down into the subsoil, where it is left. It is usually not carried deeper than 2½ feet. This makes the upper layer lighter in texture or more sandy and the upper subsoil much more like clay, producing not a hardpan but a claypan or clay layer. Below this the material has about the same constitution as originally. This action takes place only on the flat or nearly flat areas. In this county it has affected only the top layer of the soil material or the layer that forms the Grundy soils.

The Buckner fine sandy loam is an inextensive type found as isolated mounds in the flood plains of some of the larger streams. It is derived from glacial deposits.

In addition to the foregoing soils and soil material, there are stretches of recently laid alluvial materials along the streams, and small areas of old alluvial deposits. The former have been weathered into two series of soils, a brown series which is designated as the Genesee and a black group designated as the Wabash soils.

The old alluvial material has been converted into soils very much like the Grundy by the same processes that have acted on all the soil materials, and having operated on a flat surface on part of the Grundy areas, as well as on the old alluvial areas, the results have been about the same. Nevertheless these terrace soils have been placed in a separate group, the Chariton series, because of the alluvial origin of their material.

In the table below are given the names and the relative and actual extent of the soils of Grundy County:

Areas of different soils.

Soil.	Acres.	Per cent.	Soil.	Acres.	Per cent.
Shelby loam	117,312	41.7	Rough stony land	7,360	2.6
Wabash silt loam	28,480	17.5	Chariton silt loam	4,224	1.5
Colluvial phase	20,992		Genesee very fine sandy loam	4,224	1.5
Grundy silt loam	31,744	17.1	Boone very fine sandy loam	448	.1
Heavy-subsoil phase	16,320		Buckner fine sandy loam	64	.1
Wabash clay	22,272	7.9			
Wabash clay loam	15,104	5.4	Total	281,600	
Lindley silty clay loam	13,056	4.6			

GRUNDY SERIES.

The soils of the Grundy series are dark brown in color, ranging from black on the one hand to brown on the other, and range in thickness from 6 to 20 inches, with an average of about 8. The lower part of the soil or surface layer is lighter in color than the upper part, giving a suggestion of a subsurface gray layer. On level areas this is well enough developed to be noticeable. The soil becomes somewhat heavier with depth, but more rapidly as it approaches the top of the subsoil. The transition from soil to subsoil is, however, never abrupt. The upper subsoil is mottled, heavy, and rather plastic when wet, and hard when dry, the mottling consisting of dark drab and yellowish brown. This layer is 6 to 10 inches thick and passes gradually into a layer of somewhat lighter texture and lighter color. The dark drab of the upper subsoil becomes drab and the spots less well defined, while the yellowish brown becomes yellow, making the color of the deeper subsoil yellowish gray. The topography is gently rolling and the derivation is from a silty to silty clay layer overlying the Kansan drift sheet in Missouri, Kansas, Nebraska, and Iowa. In Grundy County only the silt loam type is mapped.

GRUNDY SILT LOAM.

The soil of the Grundy silt loam is predominantly dark brown, almost black when in a very wet condition. Whey dry there is a

grayish shade, giving it a dark-grayish rather than dark-brown color. The surface 3 or 4 inches usually ranges from a light loam to light silt loam, below which it becomes slightly heavier. At about the maximum depth of cultivation faint gray mottlings appear, increasing in extent until the entire subsurface soil when dry and pulverized has a distinct light-gray or ashy-gray appearance. This lighter colored layer also becomes gradually heavier in texture, so that in the lower part of the section it is, when moist, quite sticky and puttylike. At a depth which varies, but in this county averages about 18 inches, the gray layer becomes quite heavy with a peculiar granular structure and is immediately underlain by a dark-brown or dark-gray, heavy, tenacious clay. This is mottled with light-brown, yellowish-brown, or dark-brown spots and frequently contains small, shotlike iron concretions. At a depth of about 24 inches this heavy clay layer becomes slightly more silty, the mottlings are less pronounced, and it assumes a drab or light yellowish gray appearance. The lower subsoil is quite brittle when dry, and in places contains sand and gravel like that found in the Shelby soils, although this material is not found in the surface or upper subsoil layer.

This type occupies the highest elevations in the county, occurring as long, narrow strips along the crests of the divides or as isolated patches which are the remnants of such strips. In the southwestern part of the county it is represented by a rather large, irregular body, branches of which extend out between the upper courses of the streams which flow into Grand River.

Although this type is confined principally to the higher portions of the upland ridges, there are in many places long, gentle slopes extending from near the stream flood plains to the upland, upon which the conditions for the accumulation of the silty surface soil and the formation of layers in the subsoil have been almost identical with those on the uplands, and the same character of soil has resulted. In some places the gently sloping areas are continuous with the upland, while in others they are separated from it by a narrow strip of the heavy-subsoil phase of this type or of Shelby loam, which usually occurs near the top of the slope, where the grade is steepest and conditions have been most favorable for erosion.

In other places there are shallow, basinlike depressions around the heads of some of the small branches and gullies which contain a soil slightly different from the typical upland soil. In these depressions the soil is darker in color at the surface, being black when moist, and is slightly lighter in texture. These depressions seem to have been formed by the letting down of soil particles by underground solution rather than by erosion. This movement has tended to break up

the sharply defined layers. These areas have also been favorably situated for catching finely divided wind-blown material and also for the accumulation and decay of larger quantities of organic matter than would occur on the more rolling areas. This black soil resembles quite closely the Carrington silt loam, but on account of the small size of the areas they have been included with the Grundy silt loam.

The surface of the Grundy silt loam is gently undulating to rolling and well drained. This type is the nearest approach to prairie or open grass land to be found in the county and is usually locally referred to as prairie, although it is said to have borne a scattered growth of trees when settlers first came into the county.

The soil is well filled with humus and is productive. It produces good crops of corn, oats, wheat, meadow and pasture grasses, and clover. There are good alfalfa fields on this type. Corn yields 30 to 50 bushels per acre, oats about the same, wheat 15 to 25 bushels, timothy 1 ton to 2 tons, and clover 1½ to 2½ tons at two cuttings.

The Grundy silt loam differs from the closely related Putnam silt loam which is developed on the flat, grassy prairies of the northeastern part of Missouri. It is darker and browner at the surface than the latter soil. The subsurface gray layer is not so light a gray nor so silty. The transitions from dark surface soil to gray subsoil and from the gray upper subsoil to the heavy clay are not so sharp or clearly defined, while the heavy clay layer is much more pervious. The Grundy has better surface drainage and underdrainage, is usually less acid, and as a whole is a better soil. It is in particular better suited to clover and alfalfa.

Grundy silt loam, heavy-subsoil phase.—The Grundy silt loam, heavy-subsoil phase, is dark brown at the surface when moist, but whey dry shows a light yellowish brown tinge. In texture it is a rather heavy silt loam, becoming still heavier with depth. At about the depth reached by the deepest cultivation it becomes slightly lighter in color, but lacks the gray mottling of the typical Grundy silt loam adjacent to it. At a depth of 16 to 18 inches it grades into a stiff, yellowish or yellowish-brown clay without any very well-defined line of transition being developed. This extends to a depth of 24 to 30 inches, where it grades into a drab, more silty soil. This may extend to a depth of 36 inches or may at a less depth be underlain by the yellow sandy and gravelly clay subsoil of the Shelby loam.

Areas of this phase surround the main type, separating it from the Shelby loam, which occupies the slopes immediately below it. In some places where there are no areas of the typical soil this phase occupies the crest of the uplands instead. In other places strips of the phase extend from one isolated patch of the typical soil to another. Even where not mapped strips of it, too narrow to be shown

on the soil map, may extend between the typical soil and the Shelby loam.

The Grundy silt loam, heavy-subsoil phase, differs from the typical Grundy silt loam in having at the surface more of a yellowish-brown color, especially when dry, being slightly heavier in texture, and in lacking the sharp definition of layers differing in color and texture in the subsoil. It has also a more rolling topography and was originally forested to a greater extent. In some places the forest growth was almost exclusively white oak. The phase does not give quite such large yields of corn or oats, but is better suited to clover and alfalfa. In many places it has a Shelby subsoil below 30 inches. This phase represents a transitional stage between the silty, dark-colored, overlying Grundy soils and the more sandy and gravelly yellowish-brown Shelby soils, in which the Grundy material is eroded quite thin, has lost some of its dark color and has the distinct layers more or less broken up by underground soil and water movement, while the Shelby material has influenced it by offering better underdrainage, and in places by being mixed with it in the lower subsoil.

In the following table the average results of mechanical analyses of samples of the soil, subsoil, and lower subsoil of the typical Grundy silt loam, and the results of mechanical analyses of samples of the soil, subsoil, and lower subsoil of its heavy-subsoil phase, are given.

Mechanical analyses of Grundy silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
Typical soil:		*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
343701, 343716.	Soil	0.4	1.8	0.9	1.2	3.7	71.8	20.1
343702, 343717.	Subsoil	.9	2.1	.9	.9	3.1	65.7	26.3
343703, 343718.	Lower subsoil	.3	1.1	.6	1.1	1.4	63.4	32.0
Heavy - subsoil phase:								
343746	Soil	.1	1.2	1.2	1.6	4.2	71.0	20.8
343747	Subsoil	.3	1.4	1.3	1.3	2.0	64.8	29.0
343748	Lower subsoil	.2	.9	1.0	1.8	3.0	55.2	37.8

SHELBY SERIES.

The Shelby soils are brown to dark brown, occasionally almost black, to a depth of 5 to 15 inches. The subsoils in the upper part are brown or yellowish brown, faintly mottled with drab. The deeper subsoil is either yellowish brown, free from mottlings, or mottled yellowish brown and drab. Lime concretions are usually found in the subsoil. The upper subsoil varies much more in character than the deep subsoil, ranging from the dark-drab and yellowish-brown mottled clay much like that of the Putnam or Grundy

to a material essentially like that of the deeper Shelby subsoil. The derivation is from the Kansan drift and the topography is rolling. In Grundy County this series embraces only the loam member.

SHELBY LOAM.

The Shelby loam is a dark-brown loam, light in texture at the surface, but becoming slightly heavier with increasing depth. At a depth of about 8 inches it becomes light brown in color and grades abruptly into a heavy loam, and the latter into a sticky sandy clay loam at about 12 inches. This is distinctly mottled with brown, dark brown, and red or yellowish brown. In some places, especially in the more nearly level areas, there is also a mottling of light gray. Below 15 inches the soil grades into a heavy, tenacious yellow, and in some places drab or gray, clay with only faint mottlings. This continues with little change in color or texture to a depth of 3 feet or more. Scattered over the surface of this type there are sand grains of various sizes, some sharp and some well rounded. Where conditions have been favorable for the washing away of the finer material the surface soil is often quite sandy. Gravel and pebbles are also found over the surface and embedded in the soil and subsoil. Much of this gravel is of foreign origin, consisting of quartz, granite, greenstone, and many other crystalline rocks, but there are also limestone fragments from the local rock beds. Lumps of white calcareous material called "chalk" and bands and diagonal streaks of soil well filled with the same material are common. Deep well and pit silo excavations on the uplands show the same material extending to a depth of 30 or 40 feet or more. In some places it probably extends to a much greater depth.

The Shelby loam occurs throughout the county, occupying all of the uplands except the higher portions covered by the Grundy silt loam and its heavy-subsoil phase.

It is the most important soil type of the county, covering 41.7 per cent of the entire area. It is also subject to the greatest variation in appearance and in crop value. Variations are due to the source from which the soil has been derived, to the amount of erosion and leaching it has undergone, and to the quantity of organic matter which has been incorporated into the soil since its deposition.

Although the foreign material in this soil is more noticeable on account of being harder and resisting erosion to a greater extent, the local limestone, shale, and sandstone beds have had a very important influence on the character of the soil.

Near outcrops of limestone the soil partakes very largely of the nature of a residual limestone soil. Near beds of shale or sandstone it resembles closely the soil derived directly from these formations.

Each of these has had an important influence on the character of the Shelby loam in different parts of the county.

A freshly plowed field of this soil shows patches of light and dark brown, yellowish-brown, and gray colors. This is due to the erosion of soil in places, showing the lighter colored or mottled subsoil in some places, and to the filling in and accumulation of organic matter in others. Soil in which limestone material predominates usually has a reddish-brown shade, that which has been influenced largely by sandstone a light-brown or yellowish-brown shade, and that in which there is considerable shale material has a light-chocolate and in places a drab or purplish-brown appearance.

Owing to its sandy surface soil, heavy sandy clay subsoil, and rolling topography, this type is subject to serious injury by erosion. The more progressive farmers in Grundy County are gradually breaking their ground deeper and adding organic matter, thus increasing the capacity of the soil for taking up moisture quickly. Although the lime requirements of this type are not so high as on the Grundy silt loam, lime is usually found beneficial in getting alfalfa started.

The greater part of this type formerly supported a mixed forest growth of hickory, black and red oak, elm, cherry, honey locust, ash, box elder, and clumps of hazel, sumac, red haw, buckbrush, wild grape, and many other trees and shrubs. Close to the steeper slopes and where the soil seems to be largely of shale origin, bur and white oak and in a few places post oak predominate. Near outcrops of limestone there are walnut, hard maple, and large elm trees.

As occurring in this county the Shelby loam is a distinctly more productive soil than it is in the eastern part of the State. It is darker in color, being better supplied with organic matter, is lighter in texture, and deeper, and gives larger yields. Yields are slightly less on the average than on the adjacent Grundy silt loam. The average for corn is 35 bushels per acre, oats 30 bushels, wheat 16 bushels, and rye 20 bushels. It is used to some extent for alfalfa and results have been satisfactory (see Pl. II).

The results of mechanical analyses of samples of the soil, subsoil, and lower subsoil of the Shelby loam are given in the following table:

Mechanical analyses of Shelby loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
343704.....	Soil.....	1.0	4.4	4.6	13.4	10.0	45.7	21.1
343705.....	Subsoil.....	1.3	4.8	4.4	11.9	8.7	41.6	27.2
343706.....	Lower subsoil...	1.2	3.0	3.0	7.7	7.2	41.1	36.9

LINDLEY SERIES.

The soils of the Lindley series are typically yellowish brown, ranging from gray on the one hand to brown on the other. They are usually shallow, the soil layer being rarely more than 8 inches thick. The subsoil is yellowish to yellowish brown, or in rare cases reddish brown, usually free from mottling, or faintly mottled with gray. It is usually heavier than the soil, though it contains in many cases a considerable percentage of sand and gravel. Lime concretions are almost always present in the lower subsoil. The topography is usually rather rough and the soil was originally covered with oak and hazel bush, especially the medium-textured members. These soils are derived by weathering from the Kansan drift and occur in association with the Shelby soils. In Grundy County only the silty clay loam member of this series was recognized.

LINDLEY SILTY CLAY LOAM.

The Lindley silty clay loam consists of a dark yellowish brown, friable fine sandy loam to loam, grading rapidly heavier with increasing depth. When dry the surface in many places has an ashy-gray appearance. At a depth of about 6 inches the soil becomes a mottled light ashy gray and light-brown heavy loam, somewhat granular in structure in the lower part of the section. At a depth of about 12 inches this is underlain rather abruptly by a heavy, tenacious clay, mottled yellow, light brown, and gray. At about 26 inches the subsoil grades into a lighter gray or drab color and the texture becomes slightly more silty, the soil whey dry being slightly brittle or crumbly. Sand, gravel, and pebbles in small quantities are found in soil and subsoil. This soil is closely associated with the Shelby and Grundy soils.

The Lindley silty clay loam occurs principally in long, rather narrow strips covering the steep slopes which in many places border the wider valleys, and including the extensions of the uplands which reach out between the small streams entering these valleys. It also occurs around the sources of some of the smaller streams. The largest areas occur along the breaks west of Grand River, especially along Gees Creek and Wolf Creek, but a few small areas occur in the eastern part of the county along Medicine Creek, No Creek, and Honey Creek. Many areas, too small to be outlined on the soil map, have been included with the Shelby loam.

A large part of this type is too rough for profitable cultivation and much of it is at present covered with forest growth. It was formerly heavily timbered, the growth being almost exclusively white and bur oak. Where sufficiently level it is used for all crops of the county, the yields being considerably less than on the typical Shelby loam. It

produces fair bluegrass pasturage, and much of it can be most profitably used for that purpose. Where not too rough it can be used for wheat, clover, and cowpeas. It is also well suited to the growing of apples, grapes, and berries.

In the following table the results of mechanical analyses of samples of soil, subsoil, and lower subsoil of the Lindley silty clay loam are given.

Mechanical analyses of Lindley silty clay loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
343713	Soil	0.6	2.0	1.0	1.6	2.6	71.2	21.0
343714	Subsoil	.6	2.0	.9	1.2	3.0	64.1	28.5
343715	Lower subsoil	.1	.6	.4	.9	2.5	58.1	37.4

Wabash Series.

The Wabash series includes soils of alluvial origin, dark brown to black in color, and high in organic content, with slightly lighter drab or gray subsoils. They are developed in the first bottoms of streams of the Central Prairie States, the material being derived principally from the loessial and associated soils of the region. They are strong, productive soils, but are often subject to overflow and frequently need better drainage. In Grundy County three types of this series have been recognized, the clay, clay loam, and silt loam.

Wabash clay.

The Wabash clay is a very dark gray to black loam or clay loam, which at a depth of 6 inches or less grades into a stiff, tenacious clay of the same color. At a depth of 12 inches it becomes slightly mottled with lighter gray and gradually assumes a dark-drab color, which may continue to a depth of 3 feet or more, or may in turn grade into a black clay. Mottlings of brown or yellowish brown also occur in the subsoil, but are not very pronounced. The soil is well supplied with organic matter. It bakes and cracks badly, the wide cracks in extremely dry weather sometimes extending to a depth of over 3 feet. In places, especially where small streams from adjacent sandy hills have entered the wider valleys, small quantities of sand are scattered over the surface and through the soil and subsoil, but usually not in sufficient quantities to have much influence on the soil texture. Although sandy soil is rarely encountered within the 3-foot section, sand is frequently found around crawfish "chimneys." In digging wells sand or light sandy loam is usually encountered at

about the level of the lower part of the stream channel. In some places the type is fairly uniform over considerable areas, but in others it is uneven and spotted, the lower areas being darker in color and heavier in texture. Good examples of this may be seen in the western part of section 33, about 3 miles south of Trenton.

The Wabash clay occurs principally in the valleys of the larger streams, but small areas, many of them too small to be outlined on the soil map, occur in nearly all the stream valleys and have been included with the surrounding soils. In the valleys of Grand River and Medicine Creek and Weldon and Thompson Forks, bodies of it which vary in width from one-fourth mile to more than a mile extend along the valleys for a distance of several miles. These bodies do not usually lie adjacent to the stream channels, but occupy shallow basins between the higher ground near the stream channels and the lower slope of the adjacent uplands. Near the channels, however, old cut-offs and horseshoe lakes usually contain soil of this type, some of these being drained and farmed, while others remain as shallow wet-weather lakes.

The Wabash clay has been deposited by overflow waters having little or no current, permitting the finer particles of silt and clay to settle. Its low, poorly drained condition has been favorable for the luxuriant growth of swamp grasses and other water-loving plants, the decay of which has greatly increased the content of organic matter.

The greater part of this type is used for bluegrass pasture, but considerable areas are also used for corn, wheat, millet, and clover. Under favorable seasonal conditions yields of 50 to 75 bushels of corn per acre are obtained. Wheat usually makes a heavy growth of straw, but yields of 20 to 25 bushels are obtained. This soil is heavy and tenacious and difficult to cultivate, except when in the best moisture condition. The principal need of the type is protection from overflow and better drainage conditions.

WABASH CLAY LOAM.

The Wabash clay loam is a dark-gray soil, almost black when wet. At the surface it ranges from a medium to a heavy silt loam, grading at about 5 inches into a rather light clay loam. This is slightly mottled with lighter gray, the amount of mottling increasing with depth. At about 16 or 18 inches this lighter colored upper subsoil is underlain rather abruptly by a heavy, tenacious black clay, which extends to a depth of 3 feet or more. In many places, however, this clay layer is not so well developed and the lower subsoil consists of a light-brown heavy clay loam mottled with gray.

This type is subject to considerable variation from area to area, as well as in the 3-foot profile section. In the larger stream valleys

it often occupies areas near the stream channels, frequently occupying the low first bottoms. This low-lying, recently deposited clay loam has a yellowish-brown tinge, the gray layer being not so sharply defined and the lower subsoil not quite so heavy as in the typical soil. It is used largely for corn and is very productive. Where it occurs in the valleys of the smaller streams and adjacent to areas of Wabash clay the surface soil is in places quite gray and the upper subsoil light ashy gray. Such areas are or were originally covered with bur oak and post oak and when cultivated do not produce corn well, although timothy and small grain are very successful. The lime requirements of such areas are high and they are not well suited to clover or alfalfa. Where areas of Wabash clay and Wabash clay loam are adjacent the latter usually occupies a slightly higher position and is covered with a mixed timber growth and bluegrass, while the adjacent clay supports a scattering growth of water oak and swamp grass. Where slight depressions occur the soil is heavier, often a clay. The higher mounds and ridges are usually lighter.

The Wabash clay loam has been formed by deposition from flood water under conditions which permitted the settling of material slightly coarser than that which formed the clay. In some places where small streams have entered the larger valleys strips of this lighter soil have been deposited over areas of Wabash clay.

Except in the low bottoms, this type is used extensively for pasture, although considerable areas of it are used for corn and the other crops of the county. Under average conditions it does not seem to be quite so productive as the heavier clay or the lighter silt loam.

Areas of this type occur throughout the larger stream valleys and in many other places. Small areas of it are in many places included within areas of the Wabash clay on the one hand and of the lighter silt loam on the other.

WABASH SILT LOAM.

The Wabash silt loam is characteristically a dark-gray or slightly brownish gray silt loam, rather sticky when wet but loose and friable under favorable moisture conditions. The texture becomes slightly heavier with increasing depth. At about 8 inches mottlings of a lighter gray appear and become sufficiently numerous to give the soil a distinctly grayish appearance when dry and thoroughly mixed. At a depth of about 16 inches the mottlings become less pronounced and the soil in many places becomes heavier in texture, being a heavy silt loam or clay loam. On account of its wide distribution, large area, and high agricultural value it is the most important alluvial soil type of the county.

Two variations from the typical soil should be noted. In the valleys of the larger streams bodies of this type adjacent to the stream channels are slightly brownish in color, the gray layer being only slightly developed and the lower subsoil often grading into a silt loam lighter in color and texture than the surface soil. The type here approaches the Sarpy silt loam. Soil of this kind is used extensively for alfalfa and is one of the most productive corn soils in the county. In places in the valleys of the smaller streams and in some of the larger valleys where the smaller streams flow across them small areas of light ashy gray soils have been deposited. Where soil of this character occurs at the surface it belongs to the Waverly series. In this county, however, the greater part of the gray silt has received a surface covering of several inches of a darker colored silt loam and is a more productive soil than the typical Waverly silt loam. For this reason it has been included with the Wabash silt loam, although it is not quite so productive a soil, especially for corn. A few small areas of typical Waverly soil were encountered, but owing to their small size these have also been included with the Wabash silt loam.

The Wabash silt loam is a loose, friable, easily cultivated soil, well supplied with organic matter and suited to all the crops of the county. It is usually better drained than the heavier members of the Wabash series, but like those types is in most cases subject to overflow and frequently needs better drainage. Corn yields 40 to 75 bushels, wheat 15 to 25 bushels, and oats 30 to 40 bushels.

Wabash silt loam, colluvial phase.—The soil mapped as the colluvial phase of the Wabash silt loam may be described as a very dark gray to black fine sandy loam to silt loam at the surface, grading into a silt loam or heavier silt loam at 3 or 4 inches and continuing heavier with increasing depth. At a depth of 8 inches slight mottlings of gray begin and continue to a depth of 18 inches. Below this the subsoil grades into a dark brownish gray or black heavy silt loam or clay loam, and this at about 28 inches into a black sandy clay.

This soil has been formed by the gradual movement of soil particles down the slopes through the action of gravity, aided by loosening of the soil by percolating water, cultivation, trampling by stock, and wind action. It is composed of particles from the looser adjacent soils and is well supplied with organic matter.

This type occurs in the valleys of all the small streams in the county. Even the smallest branches have a strip of wash along them. An obstruction in a roadside gully will at the first rain cause the formation of a small area of this soil. In the large valleys narrow strips of the same material occur immediately below the steep slope of the upland, and where small streams enter these larger valleys alluvial fans of it are formed.

This type, if it occurred in larger bodies, would be one of the most desirable soils in the county, for it represents the rich soil material lost from the adjacent uplands by erosion. It usually occurs, however, in small bodies, and these are frequently so cut up by deep gullies that they can not be profitably cultivated. In many places better drainage is needed. Under favorable seasonal conditions excellent yields of corn are produced. Small grains usually grow too rank.

Genesee Series

The soils of the Genesee series are brown, varying from dark brown to grayish brown. They are developed mainly along the major streams and their tributaries throughout the northeastern glaciated region, particularly where the Dunkirk, Volusia, Miami, and Ontario series constitute the principal upland soils, but may occur elsewhere in the glaciated region, or even a short distance south of it, where the main streams flow from areas of these series. The Genesee soils are alluvial in origin and subject to frequent or annual overflow. Only the very fine sandy loam type is found in Grundy County.

Genesee very fine sandy loam.

The Genesee very fine sandy loam is characteristically a light brownish gray very fine sandy loam, loose and friable, but having a rather silty texture, frequently approaching a silt loam. Below 7 inches it becomes slightly lighter brown in color, with a few faint mottlings of light gray. The texture also grades somewhat lighter. At about 18 inches the subsoil grades into a light silt loam, and this at about 26 inches into a heavy silt loam with pronounced gray mottlings, these being sufficiently abundant to give the soil a distinctly gray appearance. Considerable variation is found in the subsoil of this type, thin layers of fine sand alternating with layers of heavy silt being of common occurrence.

The principal areas of this type occur adjacent to the channels of Thompson and Weldon Forks, Grand River, and Sugar and Coon Creeks. In many places it forms low natural levees, the soil adjacent to the stream channel being coarser in texture. On the side away from the stream it grades into the adjacent silt loam without sharp boundary lines. Adjacent to the channels of the larger creeks of the county, along abandoned stream channels, and around the outer edge of the horseshoe lakes narrow strips of this type, too small to be shown on the soil map, frequently occur.

The Genesee very fine sandy loam is loose and friable, easily cultivated, and holds moisture well. It is well suited to the principal crops of the county, especially to alfalfa, potatoes, tomatoes, melons,

and other truck crops. Corn yields 40 to 75 bushels and potatoes 150 to 200 bushels per acre.

Chariton Series.

The Chariton soils are dark in color, ranging from dark gray to black. They belong to the Terrace group of soils in the River Flood Plains Province. The material is an ancient flood-plain deposit of the Chariton River and its tributaries, which carry and deposit material derived almost exclusively from the Kansan till and the silty clay layer that overlies it in the Middle Western States. There are usually three layers of material in the 3-foot soil and subsoil section. The upper layer is light, the lower intermediate, and the middle layer, which usually extends from about 16 to 24 inches in depth, heavy. In Grundy County only the silt loam member is mapped.

Chariton silt loam.

As typically developed, the Chariton silt loam is a dark silt loam which becomes slightly heavier in texture with increasing depth. At about 8 inches faint mottlings of lighter gray begin, which increase in extent until the material, when dry and pulverized, assumes a light ashy gray color. This is underlain at depths ranging from 15 to 18 inches by a dark-gray or dark brownish gray clay mottled with yellow, brown, and light brown. Below 26 inches the mottling becomes less pronounced and the texture slightly lighter, the lower part of the section being a light-drab, rather brittle silty clay, sligh friable when dry. Small areas occur in which the surface soil is lighter gray than usual, and in which small iron concretions are scattered on the surface and throughout the soil. In such places the gray subsurface layer is lighter in color and the heavy clay is reached at a depth of about 15 inches.

The forest growth on this lighter colored soil consists mainly of bur oak and post oak.

The principal areas of this type occur on the east side of the valley of Thompson Fork in the extreme northwestern part of the county, on the east side of the valley of Weldon Fork near Tindall, and in the vicinity of Trenton.

The Chariton silt loam occupies terraces along the edge of the larger stream valleys and in some places along the smaller valleys. These terraces are 30 to 60 feet above the present flood plain of the streams and are high above any recent stage of flood water. The type is usually separated from the soils of the valley proper by a strip of Shelby loam, which is usually too narrow to be shown on the soil map. On the upland side it is frequently connected with the Grundy silt loam on the ridge by a long slope covered with the latter soil, but

may be separated from it by a strip of Shelby loam. The soil is an old alluvial deposit derived from glacial material and modified by weathering on a flat, nearly level surface.

The crop yields on the typical areas of this soil are about the same as on the Grundy silt loam. On the lighter colored areas the yields, especially of corn, are less.

The following table gives the results of mechanical analyses of samples of the soil, subsoil, and lower subsoil of the Chariton silt loam:

Mechanical analyses of Chariton silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
343743.....	Soil.....	0.6	1.6	1.2	1.2	2.1	76.8	16.7
343744.....	Subsoil.....	1.0	2.0	1.2	1.0	2.4	73.8	18.9
343745.....	Lower subsoil...	.3	1.4	.9	1.2	2.5	48.5	45.4

BOONE SERIES.

The Boone series consists of light-gray soils, containing a small quantity of organic matter, underlain by pale-yellowish to slightly reddish yellow and often mottled, porous subsoils. A bedrock substratum is frequently encountered at a shallow depth. The soils of this series are of residual origin, being derived from sandstones and shales principally of Carboniferous age. The topography is rolling to steeply sloping, and the soils are usually timbered. In Grundy County the series includes only the very fine sandy loam type.

BOONE VERY FINE SANDY LOAM.

Typically the Boone very fine sandy loam, to a depth of 7 or 8 inches, is a light-yellowish or grayish-brown fine to very fine sandy loam, below which it becomes distinctly lighter in color, being buff or very light brown. The subsoil contains mottlings of lighter gray, which increase with depth. At about 15 inches the soil becomes distinctly heavier, grading into a heavy loam, and then into a clay loam mottled reddish and yellowish brown. At a depth which may vary from 18 to 30 inches, soft, partly disintegrated sandstone or sandy shale is encountered. In cultivated fields the soil has a mottled light-brown and darker appearance, and in places the surface soil is well filled with small fragments of sandstone.

This type occurs only in a few small areas on rather steep hill slopes, where the erosion of the glacial soils has exposed or almost exposed the underlying sandstone beds. On many of the slopes the areas are so small and so mixed with the glacial material washed down from the slopes above that their separation is almost impos-

sible. On nearly all the steeper slopes, at or slightly below the horizon of the sandstone, the soils have been influenced by the residual sandy material. The principal areas are found to the southwest of Trenton.

This soil is used for the ordinary crops of the county, but is of rather low agricultural value, yielding about 25 to 30 bushels of corn, 25 bushels of oats, and 12 bushels of wheat per acre. It is not a good clover or alfalfa soil, although attempts are being made to use it for the latter legume.

Buckner Series.

The surface soils of the Buckner series are dark brown to nearly black in color. The subsoils are lighter in color and frequently lighter in texture than the surface soils. The series is developed as terraces or flat-topped ridges, holding essentially the position of a terrace or second bottom in the alluvial bottoms of the Mississippi River and such tributaries as the Missouri. The material is alluvial in origin. In Grundy County the series is represented by the fine sandy loam member.

BUCKNER FINE SANDY LOAM.

The Buckner fine sandy loam is a dark chocolate brown fine sandy loam, light in texture. At 7 inches it becomes slightly lighter brown in color, but the texture remains about the same to a depth of 30 inches, below which it grades into a brown loam, light in texture. This type occurs in the flood plain of Grand River and Weldon and Thompson Forks as small, isolated mounds or "islands," which are supposed to be remnants of glacial material deposited in the valleys and not entirely removed. On account of the limited area covered by the type it is of little importance agriculturally. It is best suited to melons and other truck crops.

Miscellaneous Material.

ROUGH STONY LAND.

Rough stony land consists of a reddish or yellowish-brown silt loam which usually grades into a clay loam or clay a short distance below the surface. Rock fragments and outcrops occupy about 50 per cent of the surface, and rock beds are encountered at depths which range from a few inches to 2 or 3 feet. These rock beds are principally limestone, but in some places shale and sandstone are also included. The surface of much of the type is rough and broken, and only very small areas can be cultivated. Where cultivated the soil is quite productive, being used for orchards and cultivated crops.

The greater part of the type is forested with walnut, hard maple, white oak, and elm. Hickory, black and red oak, and a mixed timber

growth is found along the edge of this type where it is modified by the adjacent Shelby loam. Where the underlying rock beds are shale or sandstone the forest growth is principally white oak or bur oak, and in places black oak.

The principal areas of the Rough stony land are found in the western and southwestern parts of the county.

This type embraces the principal areas of waste land in the county. The greater part of it, however, is used for pasture land. Even where the rock beds come within a few inches of the surface the soil produces luxuriant growths of bluegrass. Many stockmen claim that grass grown on this limestone soil produces fat more quickly than that grown on the glacial or alluvial soils. Many areas at present overgrown with small trees and brush could be profitably cleared and put into bluegrass.

SUMMARY.

Grundy County, situated in the north-central part of Missouri, has an area of 440 square miles, or 281,600 acres.

The topography of the greater part of the county is rolling to very rolling and consists of long ridges of upland separated by long, broad, and nearly parallel valleys. The surface of much of the southwestern part of the county is more broken, but also includes undulating areas of importance.

The main stream valleys are broad and flat and subject to occasional overflows.

The county is well supplied with public roads, usually on land lines. It also has good transportation facilities, being crossed by three railroad lines, which furnish direct communication with Kansas City, St. Joseph, and Chicago.

Trenton, near the center of the county, is an important railroad center, with manufacturing and commercial interests. Laredo, Spickard, and Galt are other towns of importance.

The climate, with an average precipitation of 33.64 inches, favorably distributed, and a growing season of 172 days, is very favorable for agriculture.

Stock raising is the principal industry, being carried on in conjunction with general farming. As a result of this method of farming the soils of the county are in a high state of productiveness. At present the greater part of the county is under cultivation or in pasture land.

Corn yields average about 35 to 40 bushels per acre on the better upland soils and 50 bushels on the better bottom-land soils. The yields are gradually increasing. Oats are grown quite extensively, fair yields being obtained. At present alfalfa is receiving much attention.

Farm improvements are good, including silos and power equipment on many farms. Modern farm machinery is in general use.

Land prices range from $40 to $50 an acre for the less desirable land to over $100 for the better located and well-improved land, the average being about $80 an acre.

The soils of the county are residual, glacial, and alluvial.

The residual soils are the least extensive, as well as of the lowest value agriculturally. They comprise the Boone very fine sandy loam, derived from a bed of soft sandstone, and Rough stony land, which consists largely of soil derived from the Bethany Falls limestone and of the underlying Pleasanton shales.

The glacial soils are the most important, including the Grundy silt loam and its heavy-subsoil phase, the Shelby loam, and the Lindley silty clay loam.

The Grundy silt loam is a dark brownish gray soil with a rather gray upper subsoil and heavy mottled clay below. It occupies the ridges and is well suited to corn, oats, and wheat. Its heavy-subsoil phase is lighter brown in color, without distinct layers in the subsoil, and occasionally with gravel and sandy material in the lower subsoil. It is slightly less productive than the main type, but is better suited to clover and alfalfa.

The Shelby loam is a brown soil with heavy sandy clay subsoil and having gravel and bowlders of foreign material imbedded in both soil and subsoil. It is the most widely distributed soil in the county and gives fair yields of all crops.

The Lindley silty clay loam occurs principally on the steeper slopes and is less desirable for farming than the Shelby loam.

The alluvial soils consist principally of the Wabash series, of which the silt loam is the most extensive and also the most easily handled type. It occurs in all of the principal stream valleys and is extensively farmed. The colluvial phase of this type is found in all the small stream valleys, below the steep slopes adjacent to the larger valleys, and at the outlet of small streams into these valleys. It is a rich soil, but frequently so gullied that it can not be cultivated to advantage.

The Wabash clay and clay loam are heavy, dark-colored soils, used extensively for pasturage, and to some extent for corn. Under favorable seasonal conditions good yields are obtained.

The Genesee very fine sandy loam is a light-brown soil which occurs in places near the channels of the larger streams and is used extensively for alfalfa and garden truck.

The Chariton silt loam is a terrace type, which closely resembles physically and in crop value the Grundy silt loam.

The Buckner fine sandy loam is an unimportant type.

○

[PUBLIC RESOLUTION—No 9.]

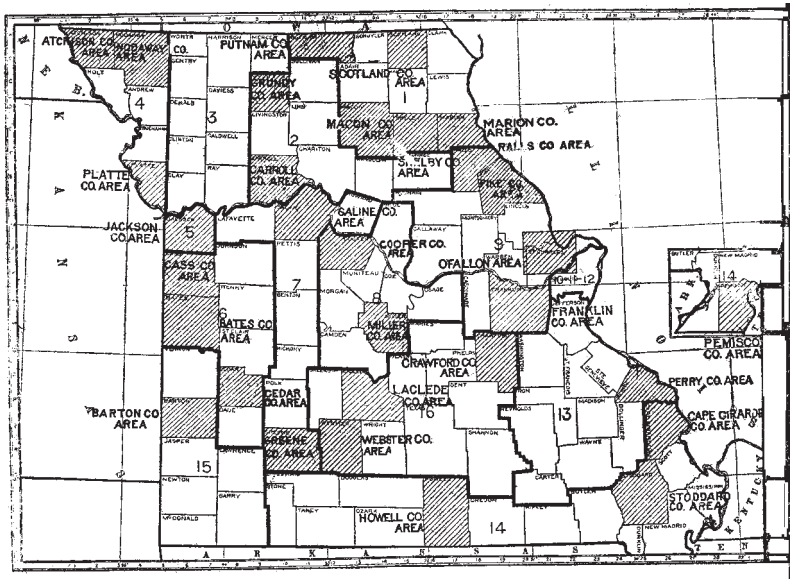
JOINT RESOLUTION Amending public resolution numbered eight, Fifty-sixth Congress, second session, approved February twenty-third, nineteen hundred and one, "providing for the printing annually of the report on field operations of the Division of Soils, Department of Agriculture."

Resolved by the Senate and House of Representatives of the United States of America in Congress assembled, That public resolution numbered eight, Fifty-sixth Congress, second session, approved February twenty-third, nineteen hundred and one, be amended by striking out all after the resolving clause and inserting in lieu thereof the following:

That there shall be printed ten thousand five hundred copies of the report on field operations of the Division of Soils, Department of Agriculture, of which one thousand five hundred copies shall be for the use of the Senate, three thousand copies for the use of the House of Representatives, and six thousand copies for the use of the Department of Agriculture: *Provided*, That in addition to the number of copies above provided for there shall be printed, as soon as the manuscript can be prepared, with the necessary maps and illustrations to accompany it, a report on each area surveyed, in the form of advance sheets, bound in paper covers, of which five hundred copies shall be for the use of each Senator from the State, two thousand copies for the use of each Representative for the congressional district or districts in which the survey is made, and one thousand copies for the use of the Department of Agriculture.

Approved March 14, 1904.

[On July 1, 1901, the Division of Soils was reorganized as the Bureau of Soils.]



Areas surveyed in Missouri.

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U.S. DEPT. OF AGRICULTURE
BUREAU OF SOILS
MILTON WHITNEY, CHIEF
CURTIS F. MARBUT, IN CHARGE SOIL SURVEY

SOIL MAP
MISSOURI
GRUNDY COUNTY SHEET

UNIVERSITY OF MISSOURI
AGRICULTURAL EXPERIMENT STATION
F.B. MUMFORD, DIRECTOR

SOIL PROFILE
(3 feet deep)

- Grundy silt loam — Sil / C / Sic
- Heavy-subsoil phase — Sicl / Hc / Sic
- Wabash clay loam — Sil / C
- Wabash silt loam — Sil / Sil / Cl
- Colluvial phase — Sil / Sicl
- Wabash clay — Cl / C
- Chariton silt loam — Sil / C / Sic
- Shelby loam — L / Cl
- Lindley silty clay loam — Sicl / Cl
- Boone very fine sandy loam — Vfsl / Vfsl / Sc / Sc
- Buckner fine sandy loam — Fsl / Fsl / L
- Genesee very fine sandy loam — Vfsl / Vfsl / Sl

LEGEND

Sil	Silt loam
C	Clay
Sic	Silty clay
Sicl	Silty clay loam
Hc	Heavy clay
Cl	Clay loam
L	Loam
Vfsl	Very fine sandy loam
Sc	Sandy clay
Fsl	Fine sandy loam

LEGEND

- Grundy silt loam — Gs
- Heavy-subsoil phase — Gs
- Chariton silt loam — Cl
- Shelby loam — Sl
- Wabash clay loam — Wl
- Lindley silty clay loam — Ll
- Wabash silt loam — Ws
- Colluvial phase — Ws
- Boone very fine sandy loam — Bl
- Buckner fine sandy loam — Bs
- Wabash clay — Wc
- Genesee very fine sandy loam — Gv
- Rough stony land — R

CONVENTIONAL SIGNS

CULTURE
(printed in black)

- City or Village, Roads, Buildings, Wharves, Jetties, Breakwater, Levee, Lighthouse, Fort.
- Secondary roads and Trails
- Railroads Steam and Electric
- Bridges, Ferry
- R. R. crossings, Tunnel
- Ford, Dam
- School or Church Cemeteries
- Mine or Quarry Mine dumps Made land
- Bluff, Escarpment, Rock outcrop and Triangulation station
- Stony and Gravelly areas
- Soil boundaries Oil wells and tanks
- Boundary lines
- Boundary lines
- Boundary lines
- U. S. township and section lines

RELIEF
(printed in brown or black)

- Contours Depression contours
- Prominent Hills Mountain Peaks
- Sand, Wash, and Sand dunes
- Shore and Low-water line, Sandbar

DRAINAGE
(printed in blue)

- Streams
- Lakes, Ponds, Intermittent lakes
- Intermittent streams
- Springs, Canals and Ditches, Flumes
- Fresh marsh Salt marshes
- Submerged marsh Tidal flats

The above signs are in current use on the soil maps. Variations from this usage appear in some maps of earlier dates.

Curtis F. Marbut, Inspector in Charge
Soils surveyed by A.T. Sweet of the U.S. Department of Agriculture and W.I. Watkins of the University of Missouri

Scale 1 inch = 1 mile

SNYDER & BLACK, N.Y.

Field Operations
Bureau of Soils
1914